METHODOLOGY FOR ESTIMATING VARIATIONS IN WASTE IN SOVIET BUNKER WEIGHT GRAIN CROPS

Fletcher Pope, Jr.
April 1975

Foreign Demand and Competition Division
Economic Research Service
U.S. Department of Agriculture

Methodology for Estimating Variations in Waste in Soviet Bunker Weight Grain Crops*

Problem

Soviet grain production as well as yield data are in terms of "bunker weight," i.e., the weight of the grain as it comes from the combines. Thus the grain contains varying amounts of moisture and foreign matter depending mainly on weather conditions during harvesting. In analyzing Soviet grain utilization, it is desirable to be able to estimate the variation from year to year in the amount of moisture and foreign matter in the grain and to reflect this variation in the amount of grain included under "waste" in the grain utilization tables.

Conclusion

The variation from average in the actual amount of precipitation received during the peak period in small grain harvesting is the main factor determining the moisture and foreign matter content of the grain. This conclusion was reached after considerable experimentation using various weather factors either singularly or in combination.

Estimation of Harvest Period

Roger S. Euler, David M. Schoonover, and I independently estimated the decade of the month which would normally be most crucial for small grain harvesting in each of 27 weather regions. Differences in these estimates for each region were reconciled in a meeting of the three estimators. Average 1969-73 harvesting progress in the Soviet Union was used in helping to reconcile any differences in the estimates and as a means of verifying the accuracy of the agreed upon harvesting period estimates. The following tabulation shows the agreed-upon most crucial 10-day harvesting period for small grains in the 27 weather regions:

Weather Region	Most Crucial Harvesting Period
Southern Ukraine	July 1-10
Moldavia	July 1-10
Krasnodar Krai	July 1-10
Northeastern Ukraine	July 11-20
Eastern Ukraine	July 11-20
Northeastern Caucasus	July 11-20

*Most of the work in developing this methodology was done in April-May 1974 and a draft statement on the results was distributed to various Soviet agricultural specialists in Washington for comments and suggestions.

Western Ukraine	July 21-31
Northcentral Ukraine	July 21-31
Western Black Soil Zone	July 21-31
Lower Volga	July 21-31
Belorussia	August 1-10
Eastern Black Soil Zone	August 1-10
Middle Volga	August 1-10
Baltics	August 11-20
Central Region	August 11-20
Upper Volga	August 11-20
Western Kazakhstan	August 11-20
Volga-Vyatsk Region	August 21-31
Northwestern Urals	August 21-31
Southern Urals	August 21-31
Northeastern Urals	Sept. 1-10
Kustanai	Sept. 1-10
Tselinograd	Sept. 1-10
Pavlodar	Sept. 1-10
Altai Krai	Sept. 1-10
Northern Kazakhstan	Sept. 11-20
Western Siberia	Sept. 11-20

Experimentation with Weather Factors

The use of factors in this exercise was limited by the types of weather data available on a regular basis as well as by the time periods and areas covered by the weather data. The main grain growing areas of the Soviet Union are divided into 27 "weather" regions and weather data are available for each 10-day period and for each month. The weather data available and their assumed impact on the amount of moisture and foreign matter in the grain are as follows:

Weather factors	Amount of moisture and foreign matter in the grain: Higher Content	Lower Content
1. Average temperature	Lower temp.	Higher temp.
2. Departure from normal temperature	Below normal	Above normal
3. Total precipitation	Much precip.	Little precip.
4. Percent of normal precipitation	Above normal	Below normal

5. Soil moisture	Higher moisture	Lower moisture
6. Percent of normal soil moisture	Above normal	Below normal
7. Change in soil moisture	Increase in moisture	Decrease in moisture

Ten-day weather data for the most crucial harvesting period in each region were used in the experimentation and a scale developed for each of the above 7 weather factors to try to quantify, both positively and negatively, the impact of each factor on the moisture and foreign matter content of the grain. The work that was done led to the conclusion that deviations from average precipitation during the most crucial 10-day harvesting period probably contributed most to differences in the amount of moisture and foreign matter in the grain as it comes from the combine but that some weight probably should be given to such deviations in precipitation during the 10-day periods both before and after the most crucial 10-day period.

Precipitation During Harvesting

Average 1963-73 precipitation in millimeters was calculated for each of the 27 weather regions (see table 1) for the following periods:

(a) Most crucial 10-day period.
(b) 10-day period prior to the most crucial period.
(c) 10-day period following the most crucial period.

The differences in millimeters between the actual amounts of precipitation received and these averages were calculated for each of the three 10-day periods for each year for each weather region. Above average amounts of precipitation were indicated by a plus sign and below average amounts by a minus sign. The precipitation difference in the most crucial 10-day period in small grain harvesting was given double the weight of the differences in either the 10-day period prior to or the 10-day period following the most crucial period in arriving at the aggregate precipitation departure from average for the three 10-day periods (see table 2).

Distribution of Small Grain Production

The percentage distribution of small grain production among the 27 weather regions was calculated for each year in the period 1963-73 (see table 3). Corn was excluded from this calculation because of the difference in time of harvesting and because corn harvested for grain is adjusted to take into account the weight of the cob and also moisture.

Calculation of Discount Factors

The plus or minus millimeter departure from average 1963-73 precipitation for each region in a given year was multiplied by the percentage of small grain production for each region that year in arriving at the discount factor for use in estimating waste in the Soviet bunker weight grain crop. The resulting factors which retained the plus or minus signs indicating above or below average precipitation were aggregated for all 27 weather regions for each year. These aggregate discount factors ranged from about a minus 2,300 in 1963 to a plus 2,700 in 1973 (see table 4). For the 11 year period 1963-73, the average of the aggregate discount factors was close to zero.

Determination of Waste Percentages

The average amount of waste in Soviet bunker weight grain is probably about 10 percent. In 1963, the planned physical weight of grain procurements in the Soviet Union (82 million tons) was about 10 percent more than the planned (74 million tons) accounting weight (Zakupki Selskokhozyaystvennykh Produktov, 1963, No. 3, p. 4). More recently, a Soviet Gosplan official at the second meeting of the US-USSR Working Group on Agricultural Economic Research and Information held in Washington in May 1974 stated that the difference between "bunker weight" grain and "standard weight" (or procured) grain averaged 6 percent. He further stated that the difference was 4 percent in dry years and 8 percent in wet years. If 3 to 4 percent of actual waste incurred in handling and storage of the grain is added to the above average of 6 percent, then total waste comes close to 10 percent.

The work done by ERS on Soviet grain utilization for the period 1964/65-1973/74 indicates that a discount (or waste) of Soviet bunker weight grain of 10 percent on average seems reasonable. Furthermore, a range in such a discount from a low of about 5 percent in very dry years to 15 percent or perhaps more in very wet years appears realistic. This range assumes that losses in dry years would be relatively small since there would be little, if any, excess moisture and foreign matter in the grain while in years when there is a lot of precipitation during harvesting excess moisture and foreign matter would add 10 percent or more to normal losses. Thus, the following schedule of discount factors and waste percentages has been assumed:

Discount factor	Waste Percentage
-2,251 to -2,750	5
-1,751 to -2,250	6
-1,251 to -1,750	7
-751 to -1,250	8
-251 to -750	9
+250 to -250	10
+251 to +750	11
+751 to +1,250	12
+1,251 to +1,750	13
+1,751 to +2,250	14
+2,251 to +2,750	15
+2,751 to +3,250	16

The following tabulation presents the discount factors resulting from the above methodology and the indicated waste for each year 1963-1973:

Year	Discount factor	Waste percentage
1963	-2,305	5
1964	+679	11
1965	+131	10
1966	-1,033	8
1967	-1,089	8
1968	-75	10
1969	+1,837	14
1970	+919	12
1971	-1,269	7
1972	-731	9
1973	+2,699	15

Summary of Results

The above results show that precipitation during small grain harvesting was unusually low in 1963 and unusually heavy in 1969 and 1973. Thus, grain waste was estimated at only 5 percent in 1963 but at 14 and 15 percent in 1969 and 1973, respectively. Also, grain waste was below average in 1971, 1966, and 1967 and above average in 1970. In the remaining 4 years, grain waste was estimated to be average (10 percent) or close to it.

In most years when estimated grain waste was significantly above or below average, precipitation during harvesting was well above or below average in both the European and Asiatic parts of the USSR (see table 4).

This was characteristic of the below-average waste years 1963, 1966, and 1971 and of the above-average waste years 1970 and 1973. On the other hand, the below-average and above-average waste estimates for 1967 and 1969, respectively, were mainly due to precipitation being below and above normal during harvesting in the European part of the Soviet Union.

Results for 1974

Estimation of waste for the 1974 grain crop was made after the basic methodology had been developed in April-May 1974 but before 1974 grain production was known. Thus, several minor changes were made in the method used in the calculation (see table 5). First, because of the late, slow start in the 1974 grain harvest, the period considered most crucial in small grain harvesting was delayed by 10 days in most weather regions in the southern part of European USSR. However, precipitation in these 1974 harvesting periods, although 10 days later, was compared to the 1963-73 averages shown in table 1 in arriving at the precipitation departures from average. Also, 1970 grain production weights for the weather regions were used in calculating the discount factors since grain distribution within the USSR that year was reasonably normal.

Grain waste from the 1974 crop was estimated at 12 percent, somewhat above normal but not as much as the waste from the 1973 crop. Precipitation during the 1974 small grain harvest was above normal in both the European and Asiatic USSR even though parts of Northern Kazakhstan and Western Siberia had experienced a severe drought earlier in the growing season (see table 5).

Any comments or suggestions on the above methodology will be appreciated.

Table 1--USSR: Precipitation by 10-day period during small grain harvesting, 1963-73 average

Weather region	6/21-30	7/1-10	7/11-20	7/21-31	8/1-10	8/11-20	8/21-31	9/1-10	9/11-20	9/21-30
					-- Millimeters --					
Baltics					20.3	17.9	24.7			
Belorussia				22.6	16.0	21.7				
Western Ukraine			31.8	26.0	15.0					
North-central Ukraine			24.3	21.4	12.4					
Northeastern Ukraine		21.4	21.0	17.0						
Eastern Ukraine		15.9	15.7	13.3						
Southern Ukraine	16.3	16.2	17.5							
Moldavia	23.1	25.0	29.2							
Krasnodar	20.9	19.1	16.4							
Northeastern Caucasus		15.4	12.0	12.2						
Western Black Soil Zone			24.2	18.8	15.6					
Eastern Black Soil Zone				18.2	14.8	24.5				
Central					19.3	20.0	16.8			
Volga-Vyatsk						17.5	15.7	17.7		
Upper Volga					12.7	21.6	14.1			
Middle Volga				16.1	10.4	16.0				
Lower Volga			14.2	8.9	11.0					
Northwestern Urals						21.4	19.7	16.9		
Southern Urals						14.6	10.7	12.0		
Northeastern Urals							20.1	13.0	13.5	
Western Kazakhstan					5.2	7.5	6.4			
Kustanai							8.8	9.5	10.4	
Tselinograd							12.6	8.5	12.5	
Northern Kazakhstan								7.2	11.7	9.0
Pavlodar							14.4	4.9	12.0	
Western Siberia								10.3	12.9	8.2
Altai							15.0	7.9	12.6	

NOTE: The middle 10-day period is considered the most crucial for small grain harvesting.

Table 2--USSR: Precipitation departures from 1963-73 averages for three 10-day Periods during small grain harvesting, 1963-73

Weather region	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
	-- Millimeters --										
Baltics	+25	-6	-31	0	+29	+20	-6	-3	-26	+41	-40
Belorussia	-15	+17	+23	+12	-3	+19	-22	+49	-43	-17	-19
Western Ukraine	-48	-13	0	+48	-48	+67	-19	+21	-49	+18	+26
North-central Ukraine	-59	+7	+15	+24	-44	+31	+11	+6	-21	0	+28
Northeastern Ukraine	-52	+55	+9	-27	-40	+13	+54	-43	+11	0	+22
Eastern Ukraine	-41	+18	+36	-23	-34	+1	+51	-27	+4	+11	+6
Southern Ukraine	-21	-24	+27	-20	-29	-6	+36	-23	+20	+32	+8
Moldavia	-13	+18	+16	-37	-75	-5	+29	+15	+36	0	+14
Krasnodar	-40	+1	-4	-28	-21	-14	+31	-22	-24	+119	+4
Northeastern Caucasus	-26	+32	-7	-19	-7	-8	+45	-10	-25	-2	+24
Western Black Soil Zone	-47	+39	+6	-12	-22	+48	+33	-23	-5	-57	+41
Eastern Black Soil Zone	-45	-9	+1	+11	+3	+3	+34	+47	-15	-68	+35
Central	+1	-12	+2	-22	+3	+5	+49	+7	-25	-49	+42
Volga-Vyatsk	-25	-14	-29	+38	-16	-27	+3	+32	+3	-40	+72
Upper Volga	+10	+34	+6	-8	-29	-45	-20	+51	+33	-59	+28
Middle Volga	-15	+13	-4	-26	+9	-26	+18	+35	+3	-33	+25
Lower Volga	-22	+11	-18	+4	+6	-5	+48	-5	-23	-36	+42
Northwestern Urals	-35	-29	+2	+28	-27	-38	+8	+72	+21	-44	+42
Southern Urals	-21	+18	-13	+14	-19	-15	-21	+48	-22	-35	+68
Northeastern Urals	-35	-5	-36	-24	-4	-2	+10	+12	-12	+9	+91
Western Kazakhstan	-3	+7	-17	-7	-8	-3	+11	+19	-12	-17	+35
Kustanai	-25	-4	-23	-19	-3	+16	+3	+26	-28	-14	+72
Tselinograd	-6	-12	+10	-29	-8	+5	-6	+27	-16	+1	+30
Northern Kazakhstan	-17	-7	-6	-14	+10	+25	-6	+7	-19	-4	+31
Pavlodar	-14	-16	+15	-18	+15	-2	+16	+20	-8	+3	-9
Western Siberia	-8	+2	+14	-22	+7	+13	+7	-10	-23	+21	-3
Altai	-15	-1	+5	-20	+4	-5	+36	-2	-10	+12	-2

NOTE: Precipitation departure from average for the most crucial 10-day period of harvesting was given twice the weight of that during the 10-day period prior to and 10-day period following the most crucial 10-day harvesting period. Minus indicate below average precipitation.

Table 3--USSR: Percentage ditribution of small grain production by weather regions, 1963-73

Weather region	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
	-- Percent --										
Baltics	2.3	2.1	3.5	1.8	2.9	2.6	3.3	2.7	3.2	2.4	2.0
Belorussia	2.6	1.7	3.2	2.0	2.6	2.1	3.1	2.6	3.4	3.2	3.0
Western Ukraine	2.7	2.0	3.8	2.4	2.9	2.1	2.7	2.1	2.5	2.2	2.5
North-central Ukraine	5.4	4.0	7.6	4.8	5.7	4.3	5.4	4.1	4.9	4.3	4.9
Northeastern Ukraine	2.1	3.2	3.7	3.2	3.1	2.3	3.1	3.0	3.4	3.0	3.3
Eastern Ukraine	3.2	4.7	5.5	4.8	4.7	3.5	4.6	4.6	5.1	4.4	5.0
Southern Ukraine	4.1	3.8	5.4	4.5	4.7	3.2	4.5	4.6	5.3	4.6	5.2
Moldavia	.7	.4	1.3	.7	.8	.3	.8	.6	.6	.8	.5
Krasnodar	3.9	2.6	2.8	3.0	2.7	2.5	1.7	3.0	2.8	2.1	3.1
Northeastern Caucasus	11.8	7.7	8.4	9.1	8.2	7.6	5.1	9.1	8.5	6.3	7.8
Western Black Soil Zone	2.6	3.1	3.7	2.8	3.0	3.1	3.8	3.1	2.8	2.6	3.4
Eastern Black Soil Zone	3.2	3.8	4.5	3.4	3.6	3.8	4.6	3.8	3.4	3.2	3.9
Central	5.7	4.4	6.7	4.2	6.5	5.2	7.6	5.8	6.4	6.2	6.2
Volga-Vyatsk	3.4	2.3	3.6	2.1	3.4	3.3	3.7	3.0	3.1	2.8	2.9
Upper Volga	3.8	3.5	3.3	2.9	3.6	3.9	2.9	3.5	2.8	2.1	3.6
Middle Volga	9.4	8.8	8.2	7.2	8.9	9.7	7.3	8.7	7.0	5.2	9.6
Lower Volga	5.7	5.3	4.9	4.3	5.4	5.8	4.4	5.2	4.2	3.1	4.2
Northwestern Urals	1.1	.9	.7	1.0	.9	1.3	1.0	.9	.8	.9	.8
Southern Urals	5.9	4.9	3.9	5.3	5.1	7.1	5.3	5.0	4.3	5.0	4.2
Northeastern Urals	3.7	3.1	2.5	3.4	3.2	4.6	3.3	3.2	2.8	3.1	2.6
Western Kazakhstan	1.6	2.6	1.0	2.3	1.5	1.8	2.1	1.8	1.8	2.7	2.0
Kustanai	2.8	4.3	1.6	3.9	2.6	3.0	3.5	3.0	3.0	4.6	3.2
Tselinograd	3.3	5.1	2.0	4.6	3.1	3.6	4.2	3.7	3.6	5.5	3.9
Northern Kazakhstan	2.2	3.4	1.3	3.1	2.1	2.4	2.8	2.4	2.4	3.6	2.6
Pavlodar	1.1	1.7	.6	1.5	1.0	1.2	1.4	1.2	1.2	1.8	1.3
Western Siberia	3.2	5.9	3.4	6.3	4.2	5.3	4.3	5.1	6.2	7.9	4.7
Altai	2.6	4.8	2.8	5.2	3.5	4.4	3.5	4.2	4.6	6.4	3.6
Totals	100.1	100.1	99.9	99.8	99.9	100.0	100.0	99.9	100.1	100.0	100.0

Table 4--USSR: Discount factors used in estimating waste, 1963-73

Weather region	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Baltics	+58	-13	-108	0	+84	+52	-20	-8	-83	+98	-80
Belorussia	-39	+29	+74	+24	-8	+40	-68	+127	-146	-54	-57
Western Ukraine	-130	-26	0	+115	-139	+141	-51	+44	-122	+40	+65
North-central Ukraine	-319	+28	+114	+115	-251	+133	+59	+25	-103	0	+137
Northeastern Ukraine	-109	+176	+33	-86	-124	+30	+167	-129	+37	0	+73
Eastern Ukraine	-131	+85	+198	-110	-160	+4	+235	-124	+20	+48	+30
Southern Ukraine	-86	-91	+146	-90	-136	-19	-162	-106	+106	+147	+42
Moldavia	-9	+7	+21	-26	-60	-2	+23	+9	+22	0	+7
Krasnodar	-156	+3	-11	-84	-57	-35	+53	-66	-67	+250	+12
Northeastern Caucasus	-307	+246	-59	-173	-57	-61	+230	-91	-212	-13	+187
Western Black Soil Zone	-122	+121	+22	-34	-66	+149	+125	-71	-14	-148	+139
Eastern Black Soil Zone	-144	-34	+4	+37	+11	+11	+156	+179	-51	-218	+136
Central	+6	-53	+13	-92	+20	+26	+372	+41	-160	-304	+260
Volga-Vyatsk	-85	-32	-104	+80	-54	-89	+11	+96	+9	-112	+209
Upper Volga	+38	+119	+20	-23	-104	-176	-58	+178	+92	-124	+101
Middle Volga	-141	+114	-33	-187	+80	-252	+131	+304	+21	-172	+240
Lower Volga	-125	+58	-88	+17	+32	-29	+211	-26	-97	-112	+176
European Sub-total	-1,801	+737	+242	-517	-989	-77	+1,738	+382	-748	-674	+1,677

Continued--

Table 4--USSR: Discount factors used in estimating waste, 1963-73--Continued

Weather region	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Northwestern Urals	-38	-26	+1	+28	-24	-49	+8	+65	+17	-40	+34
Southern Urals	-124	+88	-51	+74	-97	-106	-111	+240	-95	-175	+286
Northeastern Urals	-130	-16	-90	-82	-13	-9	+33	+38	-34	+28	+237
Western Kazakhstan	-5	+18	-17	-16	-12	-5	+23	+34	-22	-46	+70
Kustanai	-70	-17	-37	-74	-8	+48	+10	+78	-84	-64	+230
Tselinograd	-20	-61	+20	-133	-25	+18	-25	+100	-58	+6	+117
Northern Kazakhstan	-37	-24	-8	-43	+21	+60	-17	+17	-46	-14	+81
Pavlodar	-15	-27	+9	-27	+15	-2	+22	+24	-10	+5	-12
Western Siberia	-26	+12	+48	-139	+29	+69	+30	-51	-143	+166	-14
Altai	-39	-5	+14	-104	+14	-22	+126	-8	-46	+77	-7
Asiatic Sub-total	-504	-58	-111	-516	-100	+2	+99	+537	-521	-57	+1,022
USSR Total	-2,305	+679	+131	-1,033	-1,089	-75	+1,837	+919	-1,269	-731	+2,699

NOTE: The discount factors in this table were derived by multiplying the precipitation departures from average presented in table 2 by the percentage distribution of small grain production shown in table 3.

Table 5--USSR: Estimation of grain waste, 1974

Weather region	Most crucial harvesting period in 1974	Precipitation departure from average in 1974	Grain production weight for 1970	Discount factors
Baltics	8/11-20	0	2.8	0
Belorussia	8/11-20	-21	2.6	-55
Western Ukraine	8/1-10	+38	2.4	+91
North-central Ukraine	8/1-10	+33	4.0	+132
Northeastern Ukraine	7/21-31	+10	2.8	+28
Eastern Ukraine	7/21-31	0	3.9	0
Southern Ukraine	7/11-20	+12	4.7	+56
Moldavia	7/11-20	+29	0.6	+17
Krasnodar	7/11-20	-10	3.3	-33
Northeastern Caucasus	7/21-31	+15	9.3	+140
Western Black Soil Zone	8/1-10	-7	3.3	-23
Eastern Black Soil Zone	8/1-10	-7	4.4	-31
Central	8/21-31	-35	5.9	-206
Volga-Vyatsk	8/21-31	+1	3.0	+3
Upper Volga	8/11-20	+41	2.8	+115
Middle Volga	8/11-20	+10	6.8	+68
Lower Volga	8/1-10	+29	3.6	+104
European Sub-total			66.2	+406
Northwestern Urals	8/21-31	+10	1.4	+14
Southern Urals	8/21-31	-2	6.5	-13
Northeastern Urals	9/1-10	-9	4.1	-37
Western Kazakhstan	8/11-20	+25	2.0	+50
Kustanai	9/1-10	+13	3.3	+43
Tselinograd	9/1-10	+15	3.6	+54
Northern Kazakhstan	9/1-10	+28	2.7	+76
Pavlodar	8/21-31	+29	1.3	+38
Western Siberia	9/11-20	+19	5.0	+95
Altai	8/21-31	+27	3.9	+105
Asiatic Sub-total			33.8	+425
USSR total			100.0	+831